Fall and Winter Surface Water Assessment for Waterfowl Habitat

Relationship to Gulf Coast Joint Venture (GCJV) Habitat Conservation:

Priority Species: Wintering waterfowl species in the GCJV region

Planning Objective: To implement land use and conservation practices to ensure sufficient flooded agricultural lands and moist-soil habitats to meet foraging requirements for target numbers of waterfowl during fall and winter.

Type of Monitoring: Habitat

Monitoring Metric: Acres of flooded agricultural lands and moist-soil habitats

Monitoring Objective: Estimate the acres of flooded agricultural lands and moist-soil habitats during fall and winter periods [i.e., early (16 Aug–31 Oct), mid (1 Nov–15 Jan), late (16 Jan–31 Mar)] in the GCJV Chenier Plain (CPIA), Laguna Madre (LMIA), and Texas Mid-Coast Initiative Areas (TMCIA). Habitat deficits relative to objectives provide impetus for intensifying the promotion and delivery of habitat conservation actions described in GCJV initiative area plans.

Brief Methodology: Satellite imagery (e.g., Landsat TM 5 and SPOT 4/5) is inventoried for each Landsat scene (Figure 1), time period [i.e., early (16 Aug–31 Oct), mid (1 Nov–15 Jan), late (16 Jan–31 Mar)], and relevant initiative area. Seamless mosaics are created for each initiative area for each period with preference given to highest quality cloud-free images that are chronologically as close together as possible. The image mosaic is preprocessed and classified using ERDAS IMAGINE (ERDAS Inc., Norcross, GA) software. The GCJV coastal marsh and permanent water exclusion mask is applied to the image mosaic to restrict the classification to only those areas that may contain agricultural-based or moist-soil habitats. For each scene/sensor (i.e., scenes for Landsat TM 5 and scenes for SPOT 4/5) an unsupervised classification is used to separate the masked composite image into land/water classes. For any scene footprint already classified using the unsupervised classification approach mentioned above, the edited unsupervised classification can be used for a supervised classification of subsequent classifications (i.e., for past or future dates for the same sensor and scene footprint [Landsat 5 TM or SPOT 4/5]). Change vector analysis is used to extract pixels from previously classified imagery that can be used as training for supervised classifications of past or future imagery. Classifications are reviewed and erroneous data manually recoded to the correct class. A minimum mapping unit of one acre is applied. For all classifications, an estimate of misalignment and non-inclusion error associated with the exclusion mask is calculated and applied to produce a final estimate of agricultural-based and moist-soil waterfowl habitat (i.e., seasonal surface water) for each initiative area.

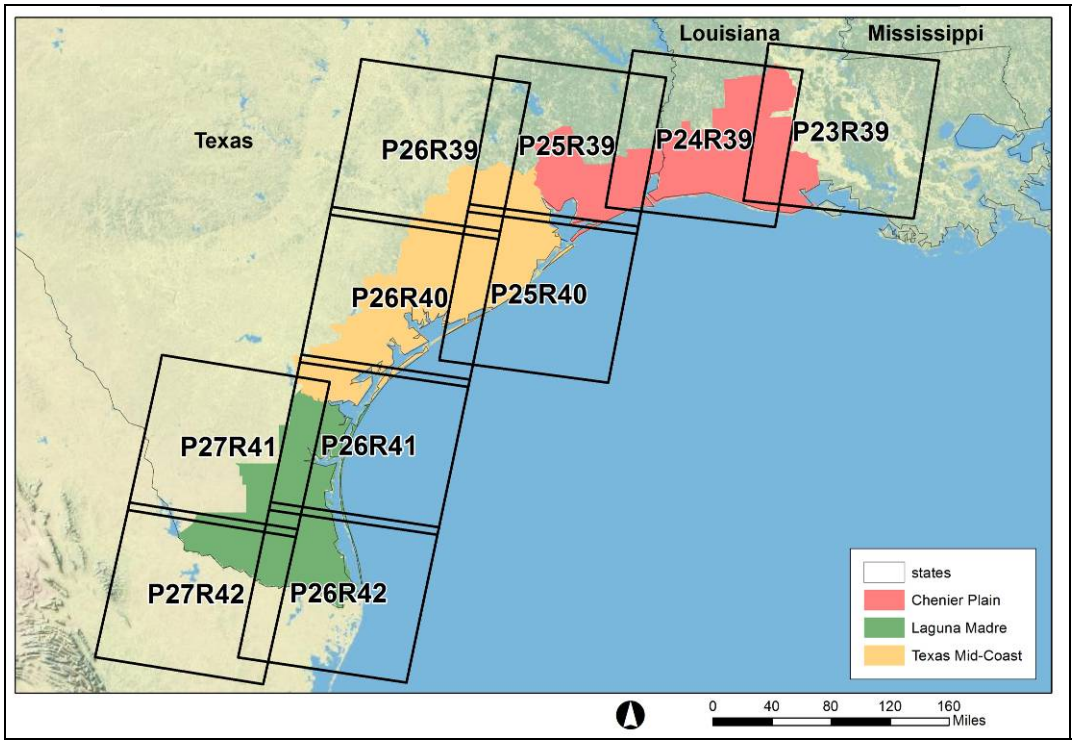

Figure 1. Coverage of Landsat TM scenes within the GCJV Chenier Plain, Laguna Madre, and Texas Mid-Coast Initiative Areas.

Monitoring Responsibilities:

Data Collection: GCJV Remote Sensing and GIS Analysts acquire satellite imagery from the U.S. Geological Survey Earth Resources Observation and Science Center.

Data Compilation and Analysis: GCJV Remote Sensing and GIS Analysts compile and classify satellite imagery.

Report Development: Acreage estimates are compiled in a chronological database by year, initiative area, and state within initiative area by the GCJV Monitoring Coordinator. Tables and graphs are produced by the GCJV Monitoring Coordinator.

Report Distribution: Data, tables, and graphs are made available upon request to the GCJV Monitoring Coordinator. Annually updated tables and graphs may be posted on the GCJV website.

Timing and Frequency:

Data Collection: Depending upon availability of cloud-free Landsat TM satellite imagery, data are collected and processed annually for three fall and winter periods [i.e., early (16 Aug–31 Oct), mid (1 Nov–15 Jan), late (16 Jan–31 Mar)].

Data Analysis: Classification of satellite imagery for the fall and winter periods of the current year is initiated at the end of each period (e.g., scenes for early winter are compiled and classified beginning 1 Nov).

Report Development: Data, tables, and graphs depicting estimated waterfowl habitat relative to GCJV objectives are updated annually by early August.

Detailed Methodology:

Data Sources and Seamless Mosaics: Satellite imagery (e.g., Landsat TM 5 and SPOT 4/5) is inventoried for each time period [i.e., early (16 Aug–31 Oct), mid (1 Nov–15 Jan), late (16 Jan–31 Mar)], and relevant initiative area. For classifications prior to 2011, Landsat TM 5 will be used (Figure 1). SPOT 4/5 will be substituted for gaps in Landsat TM coverage in fall of 2011 and be used for classifications until Landsat 8 data becomes available (e.g., recent termination of Landsat TM 5). Seamless mosaics are created for each initiative area for each period with preference given to highest quality cloud-free images that are chronologically as close together as possible. Occasionally, cloud-free imagery may only be available for parts of an initiative area. Circumstances that warrant data extrapolation are discussed in detail in a later section.

Preprocessing and Classification: SPOT 5 imagery has a 10 meter spatial resolution and is resampled to 20 meters to match the spatial resolution of SPOT 4 imagery. The image mosaic is preprocessed and classified using ERDAS IMAGINE (ERDAS Inc., Norcross, GA) software. Preprocessing involves radiometrically correcting imagery to convert digital numbers to top of atmosphere values, creating a composite image of non-thermal bands (band 6 for Landsat TM 5), the modified normalized water index (MNDWI) (Xu 2005), a normalized difference vegetation index (NDVI) (Rouse et al. 1974), and infrared-visible ratio band, and the tasseled cap transformation wetness band for Landsat TM 5 (Crist and Cicone, 1984; Crist and Kauth 1985; Scott et al. 2003). The GCJV coastal marsh and permanent water exclusion mask (Y:\Monitor\GCJV Documents\ Coastal Marsh and Permanent Water Mask - Version Final.doc) is applied to the image mosaic to restrict the classification to only those areas that may contain agricultural-based or moist-soil habitats. We have created a mask with a spatial resolution of 20 meters for use with SPOT imagery by resampling the original 30 meter mask. Initial classifications for Landsat TM 5 and SPOT 4/5 scenes are created using an unsupervised classification to separate the masked composite image into land/water classes. First, MNWDI values are used to separate pixels into three categories: 1) water; 2) combination of water and saturated lands; and 3) land. Second, pixels falling in the second category are classified as land or water using an unsupervised classification only on the second category (i.e., combination of water and saturated lands and then overlaid with the pixels that were in the first (i.e., water) and third (i.e., land) categories. Results from the unsupervised classification are reviewed and erroneous data manually recoded to the correct class.

Classification and Regression Tree Analysis: For any scene footprint already classified using the unsupervised classification approach mentioned above, the edited unsupervised classification can be used for a supervised classification of subsequent classifications of imagery from the same sensor (i.e., for past or future dates of imagery for the same scene). First, a change vector analysis is used to identify pixels that are relatively similar for both NDVI values and MNDWI values (-2.5%< x <2.5%) for two time periods (i.e., date of existing classification and date of imagery to be classified). The change vector analysis results are used to extract pixels from previously classified imagery that can be used as training for supervised classifications of additional imagery. Second, the training data is reviewed for accuracy to ensure adequate spectral representation for each class (i.e., land and water). Additional training data is added as needed. Third, the training data is used for a classification and regression tree analysis (CART) using ERDAS 2010 (ERDAS Inc., Norcross, GA), National Landcover Dataset (NLCD) Mapping Tools, and Rulequest See5 (New South Wales, Australia). Classification trees are built for each scene using a random stratified subset of 50% of the points and validated using the remaining 50% of the points. For each scene, five classifications are produced. Confidence raster's are produced with each classification containing confidence values for each pixel. Fourth, classifications are overlain and the confidence raster's are used to create a single, final classification with the class (i.e., land/water) assigned using highest confidence level. Fifth, results from the supervised classification are reviewed and erroneous data manually recoded to the correct class.

Post Processing and Parameter Adjustment: Classifications are mosaicked for the initiative area. A minimum mapping unit of one acre is applied. Classification errors associated with the exclusion mask are calculated and applied to produce a final estimate of agricultural-based and moist-soil waterfowl habitat (i.e., seasonal surface water) for each initiative area (Y:\Monitor\ GCJV Documents\Coastal Marsh and Permanent Water Mask - Version Final.doc).

Extrapolation and Landsat 5 TM Scene Exclusions: Cloud-free imagery may sometimes not be available for the entirety of an initiative area. Table 1 identifies the minimum scene requirements for image classification based on Landsat TM 5 footprints for seamless mosaics. When a seamless mosaic is missing a scene that is not essential for image classification, the estimate of seasonal waterfowl habitat is derived from available imagery and extrapolated to areas of the initiative area for which imagery is unavailable. If any essential scenes in a seamless mosaic are unavailable because of cloud cover, seasonal waterfowl habitat is not estimated for that initiative area and time period. For years with SPOT 4/5 imagery (i.e., 2010-2011, 2011-2012, and 2012-2013) GCJV staff determined whether to classify and extrapolate for seamless mosaics on a case-by-case basis using Landsat scene requirements and other considerations.

The CPIA and TMCIA have small areas that are not covered by the Landsat scenes listed in Table 1. The scenes overlapping these areas (i.e., Path 23 Row 40, Path 25 Row 40,

Path 27 Row 40) are excluded from classification because the acreage within them available for classification as potential seasonal surface water (i.e., not covered by the exclusion mask) is insignificant to the overall landscape estimates for those initiative areas.

Path 23 Row 40 is located in the southeastern portion of the CPIA. This scene contains only 1,607 classifiable acres within the CPIA, accounting for only 0.0003% of the total classifiable acres in the CPIA. Path 25 Row 40 contains the southern half of Bolivar Peninsula in the southwest portion of the CPIA. This scene contains about 9,782 classifiable acres within the CPIA, which accounts for only 0.002% of the total classifiable acres in the CPIA. An earlier classification of this area suggests the potential bias resulting from exclusion of Path 25 Row 40 from the CPIA image mosaic is small. Specifically, seasonal surface water for this area was classified using imagery for Path 25 Row 40 that was acquired on 9/4/2008. Climatological data suggested the preceding month (August 2008) was particularly wet with 8-12 inches of rainfall (PRISM Climate Group). Thus, seasonal surface water estimated from this image would likely be near the high end of potential waterfowl habitat available in this portion of Path 25 Row 40. Classification of this image revealed only 40 acres of seasonal surface water in this portion of Path 25 Row 40, providing evidence that potential bias resulting from exclusion of this scene is low.

Path 27 Row 40 (not shown in Figure 1) covers a small portion of the TMCIA. This scene contains 3,398 classifiable acres within the TMCIA, and accounts for only 0.0004% of the total classifiable acres in the TMCIA.

Table 1. Scenes required, at a minimum, for seamless mosaics for each GCJV initiative area.

Initiative area	Scenes
Chenier Plain	P25R39 & P24R39 & P23R39
Laguna Madre	P26R41& P26R42, & either P27R41or P27R42
Texas Mid-Coast	P25R40 & P26R39 & P26R40

Data and Report Archival

Y:\Monitor

- Contains a readme.doc file that describes directories and the files within them.

Y:\Monitor\Surface Water\Waterfowl

- Contains compiled data (Excel spreadsheets), tables (Word documents), and graphs relating to estimates of acres of flooded agricultural lands and moist-soil habitats during fall and winter periods in the CPIA, LMIA, and TMCIA.

Monitoring Related Issues to Consider:

None

References:

Crist E.P., and R. C. Cicone. 1984. A physically-based transformation of thematic mapper data – the TM tasseled cap. Photogrammetric Engineering and Remote Sensing 50:343-352.

Crist E. P., and R. J. Kauth. 1985. The tasseled cap de-mystified. Photogrammetric Engineering and Remote Sensing 52:81-86.

PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, Accessed 19 October 2011.

Rouse J.W., R.H. Haas, J.A. Schell, and D.W. Deering. 1974. Methods for Monitoring Multitemporal Vegetation Change Using Thematic Mapper Imagery. Remote Sensing of Environment 80:143-156.

Scott J. W., L. R. Moore, W. M. Harris, and M. D. Reed. 2003. Using the landsat 7 enhanced thematic mapper tasseled cap transformation to extract shoreline. U.S. Geological Survey Open-File Report OF 03-272.

Xu, H. 2005. A Study on Information Extraction of Water Body with the Modified Normalized Difference Water Index (MNDWI). Journal of Remote Sensing 5: 595.

---

[a]Brief and detailed methodology sections were updated in June 2013 by Enwright, Brasher, and Parr.
[b]Brief and detailed methodology sections were updated in July 2013 by Enwright and Brasher.